



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



ELSEVIER

Available online at www.sciencedirect.com

SCIENCE @ DIRECT®

Veterinary Parasitology 138 (2006) 362–365

veterinary
parasitology

www.elsevier.com/locate/vetpar

Short communication

Prevalence of anti-*Toxoplasma gondii* antibodies in serum and aqueous humor samples from cats with uveitis or systemic diseases in France

Valérie Meunier^{a,*}, Stéphane Jourda^{b,c}, Manjula Deville^c, Jacques Guillot^c

^a 30 rue Fays, 94300 Vincennes, France

^b 49 route de Paris, 78760 Pontchartrain, France

^c Service de Parasitologie-Mycologie, UMR 956 INRA, AFSSA, ENVA, UPVM, Biologie Moléculaire et Immunologie Parasitaires et Fongiques, Ecole Nationale Vétérinaire d'Alfort, 7 avenue du Général de Gaulle, 94704 Maisons-Alfort, France

Received 10 April 2005; received in revised form 30 December 2005; accepted 10 January 2006

Abstract

Anti-*Toxoplasma gondii* antibodies were determined in serum and aqueous humor of two groups of cats in France: cats with uveitis (group 1, $n = 26$) and cats with systemic disease (group 2, $n = 24$) using an agglutination test. Titres above 1:64 were considered positive. IgG antibodies to *T. gondii* were detected in 10 serum samples from group 1 and in 10 serum samples from group 2, and in 2 aqueous humor samples from group 1 and in 1 aqueous humor samples from group 2. The distribution of ocular lesions according to the serological status of the animals indicated that lens luxation and buphthalmia were more frequent in *T. gondii* seropositive cats than in seronegative ones. The study reports a similar prevalence of anti-*T. gondii* antibodies in cats with uveitis and in cats without uveitis in France. Serological results must be analysed carefully and additional diagnostic tools is required.

© 2006 Elsevier B.V. All rights reserved.

Keywords: *Toxoplasma gondii*; Cats; Uveitis; France

1. Introduction

The clinical manifestations in cats infected by *Toxoplasma gondii* are diverse with both fatal and sub-lethal chronic syndromes being reported. Intestinal toxoplasmosis, which results from the sexual replica-

tion of the parasite in feline enterocytes, may lead to self-limiting diarrhoea. The diagnosis of intestinal toxoplasmosis is based on the detection of *T. gondii* oocysts in the faeces of the cats. When extra-intestinal toxoplasmosis is acquired transplacentally or by suckling in kittens, the condition is often clinically severe. Clinical signs include fever, dyspnoea, icterus and anorexia (Dubey and Lappin, 1998). In these fatal cases, definitive diagnosis is made by histological

* Corresponding author. Tel.: +33 1 43 98 21 07.

E-mail address: v.meunier@free.fr (V. Meunier).

examination. Extra-intestinal toxoplasmosis may also be suspected in other cats with a more chronic course. The most frequent clinical finding in this form of disease is uveitis. Multifocal to diffuse retinochoroiditis, optic neuritis are signs of posterior uveitis whereas iritis, keratic precipitates, lens luxation and secondary glaucoma are present in anterior uveitis. Ocular toxoplasmosis may be unilateral or bilateral. It usually occurs alone in cats without any systemic signs of the disease (fever, dyspnoea or anorexia) (Davidson, 2000).

Since cats with a suspected *T. gondii*-induced uveitis do not die, the presence of the parasite cannot be demonstrated with certainty (Davidson and English, 1998). The presumptive diagnosis is usually based on exclusion of other potential causes of feline uveitis and the response to anti-*Toxoplasma* drugs (sulfa drugs or clindamycin). The interpretation of serological tests is not straightforward. Cats with uveitis are usually seropositive for *T. gondii* and other ocular pathogens such as feline leukaemia virus (FeLV), feline immunodeficiency virus (FIV) and feline infectious peritonitis virus (FIP) (Lappin, 2000). Moreover, the presence of anti-*T. gondii* antibodies can be demonstrated in the serum and aqueous humor of normal cats.

In the present study, we aimed at evaluating the prevalence of anti-*T. gondii* antibodies in serum and aqueous humor of cats with uveitis or systemic disease in France. We also aimed at describing the clinical ophthalmologic signs, which were more frequently associated with seropositivity.

2. Materials and methods

2.1. Sample collection

From June 2001 to June 2003, serum and aqueous humor samples were collected from two groups of adult cats living in France. Aqueous humor samples (0.5 mL) were collected by anterior chamber paracentesis, under general anesthesia. Stools (5 g) were also recovered from each animal.

The first group comprised cats ($n = 26$) with ophthalmologic evidence of uveitis. The animals were privately owned cats presented for consultation to a referent practitioner specialized in ophthalmol-

ogy. All the cats were born in and were still living in Paris or in the suburbs of Paris. Ages ranged from 1 to 15 years (mean age 9.3 years). Domestic shorthair cats composed the large majority of the animals ($n = 20$) with a Siamese and 5 Persian cats. The sex ratio was 21 males for 5 females.

These animals were presented for a complaint of a change in appearance of the affected eye(s). We selected cats with anterior uveitis or/and posterior uveitis and chorioretinitis.

The second group comprised privately owned cats ($n = 24$) living in the suburbs of Paris and presented for various systemic diseases. These cats had never presented ophthalmic evidence of uveitis. The clinical signs of the systemic diseases include anorexia, weight loss, vomiting, polyuria-polydyspsia, diarrhoea, fever or hypothermia, dehydration. Ages ranged from 2 to 19 years (mean 9.0 years) and the sex ratio was 13 males for 11 females. Twenty-two were domestic shorthair cats and 2 were Siamese.

2.2. Antibodies detection

Serological testing included detection of FeLV antigen, FIV antibodies, feline coronavirus antibodies and *T. gondii* antibodies. Commercial kits were used for FeLV and FIV (Speed duo FeLV/FIV, Bio Veto Test, La Seyne sur mer, France). An indirect fluorescent antibody assay was performed for feline coronavirus.

For the detection of antibodies to *T. gondii* in both serum samples and aqueous humors, an agglutination test (Toxo-Screen DA, Biomerieux, Marcy-l'Etoile, France) was used. This serological test is species independent and available in a commercial kit that has been developed for use in humans. Formalin-treated *T. gondii* tachyzoites agglutinate in the presence of diluted sera containing IgG and IgM antibodies. However, the use of the direct agglutination test for the detection of IgM antibodies is controversial because of the lack of specificity. As a consequence, for each sample, the test was performed with addition of 2-mercaptoethanol (0.2 mol/L) which denaturates IgM antibodies. Sera and aqueous humors were diluted 2-fold starting at 1:8 dilution. IgG titres above 1:64 were considered positive.

Seroprevalence estimates were compared by the Fischer exact test using Epi Info Software.

Table 1
Antibody titres to *T. gondii* in cats with or without uveitis in France

	Agglutination antibody IgG titres in serum samples			Agglutination antibody IgG titres in aqueous humor samples		
	<1:64	> or =1:64 and <1:512	> or =1:512	<1:64	> or =1:64 and <1:512	> or =1:512
Cats with uveitis	16	8	2	24	2	0
Cats with systemic disease	14	8	2	23	1	0

The test (Toxo-Screen DA) was performed after mercaptoethanol treatment and the titres correspond to IgG titres. Titres above 1:64 are considered positive for *T. gondii* infection.

2.3. Fecal examination

Faecal examination was performed on each cat with the flotation method using saturated magnesium sulfate solution with a specific mass of 1.28.

3. Results

IgG antibodies to *T. gondii* were detected in 10 out of 26 serum samples (38.5%) and in 10 out of 24 serum samples (42.0%) from groups 1 and 2, respectively. IgG antibodies to *T. gondii* were detected in 2 out of 26 aqueous humor samples (7.6%) and in 1 out of 24 aqueous humor (4.0%) from groups 1 and 2, respectively (Table 1). When antibodies were detected in aqueous humor samples, the serology was systematically positive from the corresponding sera. However, titres were lower in aqueous humor samples than in the serum samples.

Among the cats with uveitis, 6 out of 26 (23.0%) were positive for FIV but only two had concurrent anti-*T. gondii* antibodies, one cat (3.8%) was positive for FeLV and had concurrent anti-*T. gondii* antibodies and another one (3.8%) was positive for FIP without evidence of anti-*T. gondii* antibodies.

Among the group 2, one cat was positive for FeLV and 4 cats were suspected of FIV infection.

For the first group of cats, the following criteria were considered for the distribution of ocular lesions according to the serological status of the animals (Table 2): uni or bilateral uveitis, anterior and/or posterior uveitis, lens luxation and buphthalmia. Anterior segment disease was much more common than posterior segment disease in cats with (14/14) or without (11/12) serological evidence of *T. gondii* infection. The proportion of animals with unilateral or bilateral uveitis was similar in *T. gondii*-seropositive or seronegative cats. On the contrary, lens luxation and buphthalmia were more frequently observed in *T. gondii*-seropositive cats than in seronegative ones ($p < 0.05$).

Faecal examination was negative in all the cats tested.

4. Discussion

The present study indicated that anti-*T. gondii* antibodies can be detected in the serum of cats with uveitis (53.8%) as well as in the serum of cats with general disease (46.0%). These results are in accor-

Table 2
Distribution of ocular lesions in cats with uveitis (group 1)

	<i>T. gondii</i> seropositive ^a	<i>T. gondii</i> seronegative	Total
Anterior segment only	8	8	16
Posterior segment only	0	1	1
Anterior and posterior segment	6	3	9
Lens luxation	8	2	10
Buphthalmia	10	2	12
Unilateral uveitis	5	4	9
Bilateral uveitis	9	8	17

^a IgG antibody titer > or =1:64.

dance with those from previous studies conducted in France. Roze (1998) reported a seroprevalence of 54.1% in cats with uveitis from the South of France.

Definitive diagnosis of ocular toxoplasmosis in cats is difficult and no pathognomonic lesions have been described so far. Previous studies described specific anterior uveitis in cats (Davidson et al., 1991; Chavkin et al., 1992) with serology suggestive of toxoplasmosis. In the present study, we observed a higher number of cases of anterior uveitis but this was true in both *T. gondii*-seropositive and seronegative cats. Other clinical signs such as lens luxation and buphthalmia may be more suggestive of toxoplasmosis as we observed these signs more frequently in *T. gondii*-seropositive cats than in seronegative ones.

When toxoplasmosis is suspected in a cat, the interpretation of serological results can be difficult because of many factors. The cat population has a high exposure rate and thus many cats without evidence of disease would be expected to have a positive titer. Moreover, it is difficult to distinguish cats with primary infection, recrudescent infection or re-exposure. The IgG antibody titre can remain high for 2 years or longer.

The detection of anti-*T. gondii* antibodies in aqueous humor may be proposed as a diagnostic tool. However, we did not detect anti-*T. gondii* antibodies in aqueous humor samples from cats with uveitis. This result is in accordance with previous studies (Lappin et al., 1996a). The Goldmann-Witmer coefficient (*C*-value) can be helpful in evaluating the *T. gondii*-specific antibody in aqueous humor (Hill et al., 1995). A *C*-value > 1 is suggestive of local production of *T. gondii*-specific antibody in aqueous humor and potentially ocular toxoplasmosis. In our study, the *C*-value was not calculated because we did not have the opportunity to obtain the dosage of total antibody titres for all the animals we examined. PCR on aqueous humor seems to be more predictable of the disease but not enough to conclude on an ocular toxoplasmosis (Lappin et al., 1996b).

The high prevalence of antibodies anti-*T. gondii* in the group of cats with systemic diseases may be accounted by recrudescent infections. Another expla-

nation would be a concurrent FIV infection, which may affect humoral immune response to other infectious agents, including *T. gondii* (Lappin et al., 1992).

Faecal examination was negative in cats tested. The cats usually shed *T. gondii* oocysts for only 1–2 weeks after primary exposure.

In conclusion, the present study reports a similar prevalence of anti-*T. gondii* antibodies in cats with uveitis and in cats without uveitis. This confirms that serological results must be analyzed carefully and that the development of additional diagnostic tools is required.

References

- Chavkin, M.J., Lappin, M.R., Powell, C.C., Roberts, S.M., 1992. Seroepidemiologic and clinical observations of 93 cases of uveitis in cats. *Prog. Vet. Comp. Ophthalmol.* 2, 29–36.
- Davidson, M.G., 2000. Toxoplasmosis. *Vet. Clin. North Am. Small Anim. Pract.* 30, 1051–1062.
- Davidson, M.G., Nasisse, M.P., English, R.V., Wilcock, B.P., Jamieson, V.E., 1991. Feline anterior uveitis: a study of 53 cases. *J. Am. Anim. Hosp. Assoc.* 27, 77–83.
- Davidson, M.G., English, R.V., 1998. Feline ocular toxoplasmosis. *Vet. Ophthalmol.* 1, 71–80.
- Dubey, J.P., Lappin, M.R., 1998. Toxoplasmosis and neosporosis. In: Greene, C.E. (Ed.), *Infectious Diseases of the Dog and Cat*. Saunders, W.B., Philadelphia, pp. 493–503.
- Hill, S.L., Lappin, M.R., Carman, J., Collins, J.K., Reif, J.S., Spilker, M., Jensen, C., 1995. Comparison of methods for estimation of *Toxoplasma gondii*-specific antibody production in the aqueous humor of cats. *Am. J. Vet. Res.* 56, 1181–1187.
- Lappin, M.R., 2000. Feline infectious uveitis. *J. Feline Med. Surg.* 2, 159–163.
- Lappin, M.R., Burney, D.P., Dow, S.W., Potter, T.A., 1996a. Polymerase chain reaction for the detection of *Toxoplasma gondii* in aqueous humor of cats. *Am. J. Vet. Res.* 57, 1589–1593.
- Lappin, M.R., Greene, C.E., Winston, S., Toll, S.L., Epstein, M.E., 1996b. Clinical feline toxoplasmosis: serologic diagnosis and therapeutic management of 15 cases. *J. Vet. Intern. Med.* 3, 139–143.
- Lappin, M.R., Marks, A., Greene, C.E., Collins, J.K., Carman, J., Reif, J.S., Powell, C.C., 1992. Serologic prevalence of selected infectious diseases in cats with uveitis. *J. Am. Vet. Med. Assoc.* 210, 1005–1009.
- Roze, M., 1998. Les uvéites félines: étude clinique et sérologique de 44 cas. *Prat. Méd. Chir. Anim. Comp.* 33, 123–130.